Microgravity Biotechnology

Principal Investigator's Survival Guide

for

Flight Investigations

George C. Marshall Space Flight Center
Huntsville, Alabama 35812

Dec. 7, 1998

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1. Introduction

Congratulations on your selection as a Principal Investigator (PI) by the NASA Headquarters Microgravity Research Division (MRD). Your investigation will be managed by the Microgravity Science and Applications Program office at Marshall Space Flight Center (MSFC) in Huntsville, Alabama. You and your investigation team will be assigned an MSFC Project Scientist and Project Manager to be your NASA points of contact during the investigation process.

To help you understand the NASA process, this *Principal Investigator's Survival Guide* outlines the flight-development investigation processes, and the procurement and program control requirements. This is not an exhaustive review of NASA procedures or regulations, nor does it supersede instructions in your grant or contract. Further, no specific timetables are given as you and your NASA contacts must develop these as your investigation proceeds.

Revisions will be published as needed. In some cases, we will send only change pages with affected sections noted by a solid bar as shown on the left. However, *all investigators are advised to read this entire Guide as a number of changes have been made since it was first published in 1995; thus, changes are not marked in this edition*. The most notable changes are the inclusion of appendices that outline various reviews — separate from hardware and design reviews — that are required of each investigator.

You are welcome to comment on or suggest changes to *Principal Investigator's Survival Guide*. Please address them to:

Manager, Microgravity Systems Office—MG20
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/s/

Ron Porter, Biotechnology Program Manager

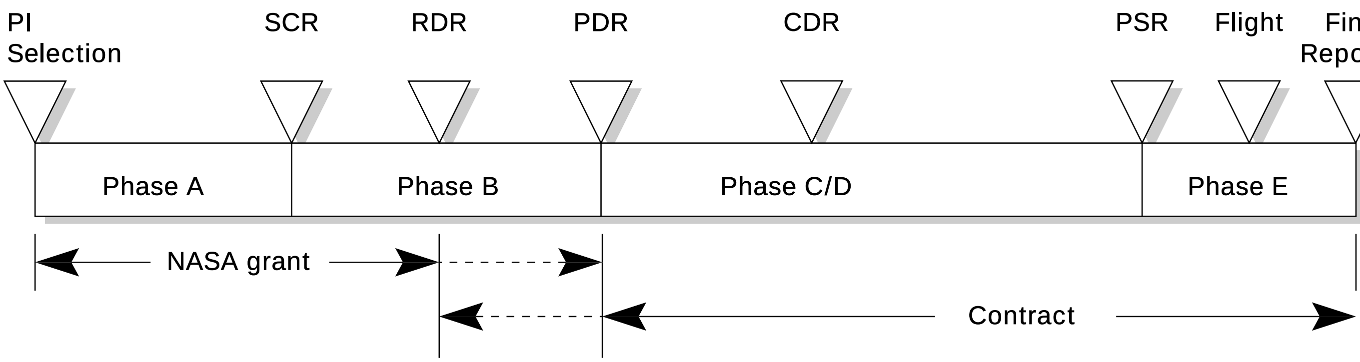
/s/

Buddy Guynes, Biotechnology Project Manager

Contents

2. Investigation Process

NASA scientific programs normally follow one of two procedures, the ground-based research program, which is a general research effort, and a flight development program, which is more rigorous and has specific goals and objectives leading to an experiment in microgravity.



Overview of timeline for a flight project.

A flight development program is accomplished in five phases spanning inception through mission results. A NASA Grant is your authority to initiate Phase A, Experiment Definition, of your investigation. The ground rules for processing and administering your grant are the same as those stated in the Ground-Based Program and apply until you transition to a contract.

All Principal Investigators, regardless of the status of their investigation, must submit an entry for the *Microgravity Research Task Book* at the end of each fiscal year.

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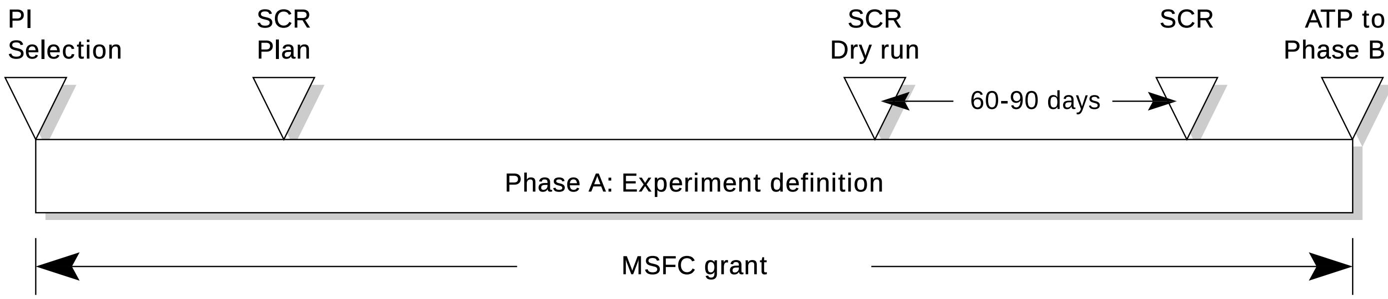


Phase A detail of flight project timeline.

Phase A (Experiment definition). As you start Phase A, you will establish a relationship with your MSFC Project Scientist and Project Manager. They will guide you through Phase A which will culminate with a formal Science Concept Review (SCR) presentation to a peer panel (page 12). Peer review is an important aspect of all NASA science activities and is used rigorously in microgravity science reviews.

The period of time required to reach the SCR depends on the intensity and complexity of your investigation. You and your Project Scientist will establish an SCR target date as your investigation matures. An SCR Plan shall be published by you and the MSFC team shortly after selection and the start of experiment definition. The SCR plan must cover the activity required to scope and define the science requirements and to prove the scientific feasibility of the experiment. Your primary responsibilities for the SCR are to present your experiment science objectives and the detailed science requirements necessary for performing the experiment in microgravity. A peer review panel will assess your science requirements and evaluate the anticipated results to determine the scientific feasibility of your proposed flight experiment.

NASA Headquarters will determine the next step in your investigation soon after the conclusion of the SCR. The options are:

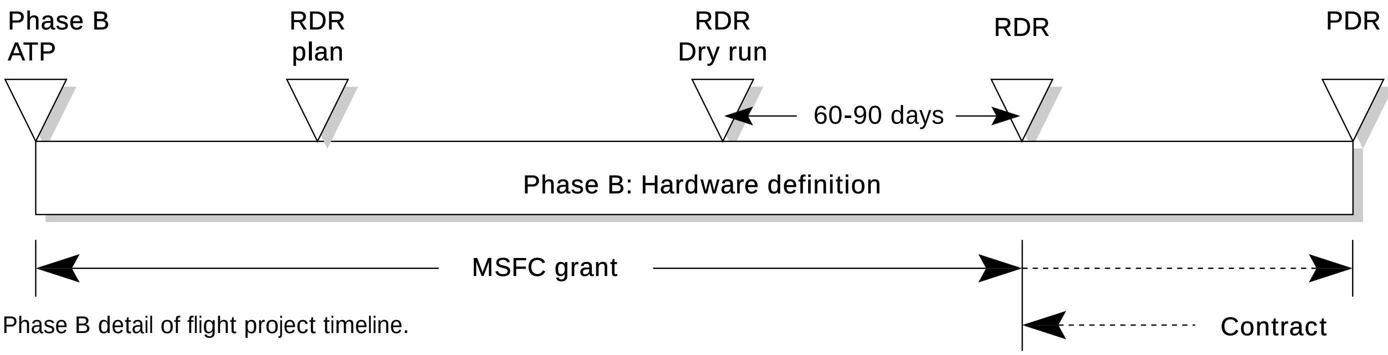
1) Your investigation proceeds into Phase B, or
2) Your investigation remains in Phase A for further resolution of scientific questions, or
3) You may be asked to repropose in the next NASA Research Announcement cycle.

Key Features of the SCR Plan

1. Science Objective
2. Science Feasibility
3. Approach
4. Schedules
5. Resources

Key Features of the SCR Presentation

1. Significance
2. Maturity
3. Objectives
4. Need for microgravity
5. Priorities within the experiment
6. Rigor of ground-based tests
7. Scientific specifications
8. Conceptual design
9. Technology issues



Phase B detail of flight project timeline.

Phase B (Hardware definition). As your investigation moves into Phase B, Hardware Definition , you will have a closer interface with the MSFC team. As your investigation moves into Phase C/D, your relationship with the MSFC team expands to include the MSFC Project Engineer. The key milestone for Phase B is a formal Requirements Definition Review (RDR) presentation to two subpanels (Engineering/Program and Science; page 18). The Project Manager and Project Scientist will assist you in establishing a target date for the RDR. An RDR plan outlining the review shall be published two to three months following the Authority to Proceed if you are developing hardware. At the RDR you must establish that you have a hardware concept capable of performing your experiment in microgravity. You must develop and present a project plan which baselines the budget and schedules which will allow the review panel to commit to hardware development.

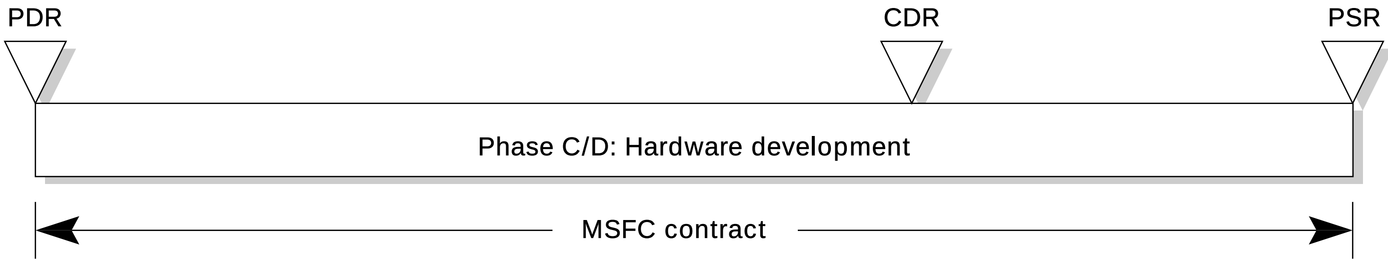
A final draft copy of your Science Requirements Document must be presented at the RDR. Review panel comments and findings will be incorporated into the final version of the Science Requirements Document which becomes the baseline for the hardware design requirements for Phase C/D, Hardware Development. After assessing the results of the RDR, the Enterprise Discipline Scientist at NASA Headquarters will recommend — with the concurrence of the Microgravity Research Division (MRD) Lead Scientist — to the MRD Director whether to proceed to flight development. If selected, you will be notified by your Project Manager and issued an Authorization to Proceed (ATP) into Phase C/D.

Key Features of the RDR Plan

1. Organization
2. Approach
3. Schedules
4. Resources
5. Hardware Implementation Plan

Key Features of the RDR Presentation

1. Science requirements document (final draft)
2. Conceptual hardware design
3. Hardware capabilities (results of engineering demonstrations and feasibility studies)
4. Hardware capabilities document (final draft)
5. Project plan (final drafts of organization, work breakdown structure [WBS], schedule, costs)
6. Selected carrier capabilities
7. Status of the SCR action items



Phase C/D detail of flight project timeline.

Phase C/D (Hardware Development). Phase C/D comprises all stages from design of the hardware through delivery of the flight units. Your primary responsibilities are to design, develop, and test the flight experiment hardware which must meet and satisfy all the science requirements and be certified for flight. Various MSFC project and mission documents will be required in parallel with your ongoing design effort. The MSFC team will assist you in setting the target dates for the major design reviews. Additional details will be supplied later.

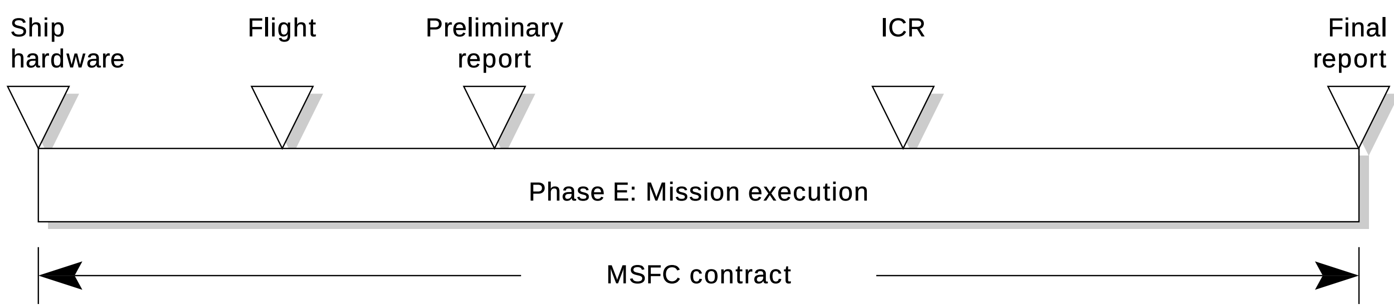
Phase C/D Milestones

PDR: Preliminary Design Review, at 10% design completion

CDR: Critical Design Review, at 90% design completion

PSR: Preship Review, hardware shipment authorization

Phase E (Mission execution). The final phase of your investigation is the mission execution phase including launch, experiment operations, and post-flight analysis. Additional details will be supplied later. Following flight, you may be asked, or may request, an Investigation Continuation Review (ICR; formerly the MSAD Hardware reflight Review) for a possible reflight of your investigation. The ICR is outlined on page 20.



Phase E detail of flight project timeline.

3. Procurement Process

The MSFC Procurement Office will write, negotiate, and administer your contract. A representative of the Procurement Office will contact your organization's business office shortly after your selection as a PI.

The Procurement Office will review your NASA Research Announcement (NRA) proposal to see that you have provided adequate support for your costs and to ensure that all required certifications and information have been submitted in order to award your grant. This type of reporting is required by law. During this review, your business office may be contacted for more information. To speed this process, please provide a contact name plus e-mail address and phone number.

Those investigators in the Flight Development Program should expect to transition from a grant to a contract following the RDR. The switch to a contract is necessary because the Government can place detailed requirements only on an organization under a contract. A grant does not contain a Statement of Work or any performance or design specifications. It is simply an agreement between the Government and an organization to perform research. This means it is very important for you to communicate frequently with your MSFC team to ensure that milestones and reviews are successfully completed and that research progresses within the framework described in this document.

Your technical primary point of contact is the Contracting Officer's Technical Representative (COTR; typically your Project Manager).

4. Program Control

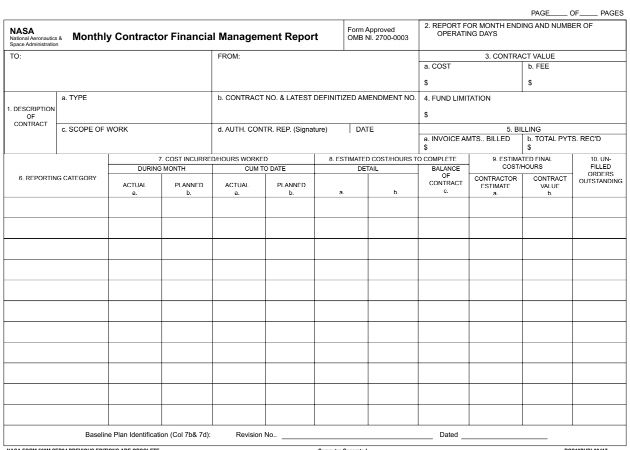
We close this guide with a brief introduction to the basic program control requirements for a NASA project. It is not an exhaustive treatment of all requirements. Opportunities will be made available for training on specific aspects of the various functions of program control.

NASA's program control responsibilities provide for the formal planning, initial funding, and monitoring of resource plans and spending against those plans. In general, you are responsible for the initial justification for your funding requirements and for the effective use of your resources—primarily funding and labor.

NASA funding is determined through a budget cycle known as a Program Operating Plan (POP) which provides funding for approved programs. Each PI, university, or contractor is expected to play a role in the POP process. Your most significant involvement will be to provide yearly projected cost plans.

In addition to the yearly budget planning process, you are required to submit quarterly financial reports like the sample shown here. The requirements for reporting cost and technical status are required by the NASA Grant Handbook and are provided by reference in the grant.

NASA Form 533M and 533Q, Contractor Financial Management Reports, are used to report expenditures for flight programs under contract to NASA. This report will provide the status of costing to a plan. Costs are "run in" for more accurate project costing—last month's actual costs and next month's estimate of costs. For the Business Management Office, Form 533M is the basis for tracking actual costs vs. planned costs on a monthly basis. MSFC submits the project status report to NASA Headquarters each month. The 533Q is required at the end of each federal quarter. *Future PI funding levels are determined by costs submitted on the 533M and 533Q.*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NASA National Aeronautics & Space Administration — Monthly Contractor Financial Management Report — Form Approved OMB NI. 2700-0003

2. REPORT FOR MONTH ENDING AND NUMBER OF OPERATING DAYS

TO: | FROM: | 3. CONTRACT VALUE: a. COST $ | b. FEE $

1. DESCRIPTION OF CONTRACT: a. TYPE | b. CONTRACT NO. & LATEST DEFINITIZED AMENDMENT NO. | 4. FUND LIMITATION $

c. SCOPE OF WORK | d. AUTH. CONTR. REP. (Signature) | DATE | 5. BILLING: a. INVOICE AMTS.. BILLED $ | b. TOTAL PYTS. REC'D $

6. REPORTING CATEGORY	7. COST INCURRED/HOURS WORKED: DURING MONTH		CUM TO DATE		8. ESTIMATED COST/HOURS TO COMPLETE: DETAIL			9. ESTIMATED FINAL COST/HOURS		10. UN-FILLED ORDERS OUTSTANDING
	ACTUAL a.	PLANNED b.	ACTUAL a.	PLANNED b.	a.	b.	BALANCE OF CONTRACT c.	CONTRACTOR ESTIMATE a.	CONTRACT VALUE b.	

Baseline Plan Identification (Col 7b& 7d): Revision No.. ____ Dated ____

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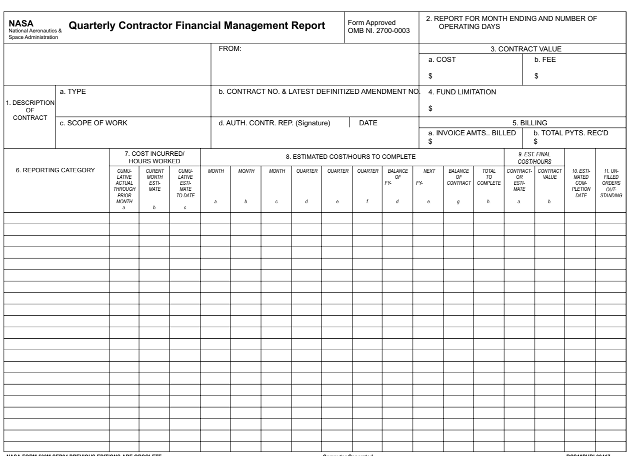
NASA National Aeronautics & Space Administration — Quarterly Contractor Financial Management Report — Form Approved OMB NI. 2700-0003

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c. SCOPE OF WORK | d. AUTH. CONTR. REP. (Signature) | DATE | 5. BILLING: a. INVOICE AMTS.. BILLED $ | b. TOTAL PYTS. REC'D $

6. REPORTING CATEGORY	7. COST INCURRED/ HOURS WORKED			8. ESTIMATED COST/HOURS TO COMPLETE										9. EST. FINAL COST/HOURS		10. ESTIMATED COMPLETION DATE	11. UNFILLED ORDERS OUTSTANDING
	CUMULATIVE ACTUAL THROUGH PRIOR MONTH a.	CURENT MONTH ESTIMATE b.	CUMULATIVE ESTIMATE TO DATE c.	MONTH a.	MONTH b.	MONTH c.	QUARTER d.	QUARTER e.	QUARTER f.	BALANCE OF FY- d.	NEXT FY- e.	BALANCE OF CONTRACT g.	TOTAL TO COMPLETE h.	CONTRACTOR ESTIMATE a.	CONTRACT VALUE b.		

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NASA Form 533 must be completed monthly (533M, top) and quarterly (533Q, bottom). If your contract starts in the middle of a month, then your report should reflect expenditures from award date through the end of the month for 533M, and through the end of the Federal fiscal quarter for 533Q (*i.e.*, not the first three months of your contract). This keeps all reports in step with the Federal fiscal calendar. Full-size copies of the 533M and 533Q, plus instructions, are on pages 23-26.

Appendices

To make the guide easier to read, we have placed details of reviews and forms in seven appendices. These are not optional pages, but contain materials that will be vital to successful completion of your project. Of special importance are the NASA Forms 533M and 533Q and the annual Data Update Form. These must be filed in a timely manner to ensure funding.

1: Acronyms & Definitions
2: Authority To Proceed (ATP)
3: Science Concept Review (SCR)
4: Requirements Definition Review (RDR)
5: Investigation Continuation Review (ICR)
6: NASA Forms 533M and 533Q
7: Data Update Form

Appendix 1
Acronyms & Definitions

ATP	Authority to Proceed
CDR	Critical Design Review
COTR	Contracting Officer’s Technical Represenmtative
DS	Discipline Scientist
ES	Enterprise Scientist
KSC	Kennedy Space Center, Florida
MRD	Microgravity Research Division
MRPO	Microgravity Research Program Office
MSAD	Microgravity Science and Applications Division
MSFC	Marshall Space Flight Center, Huntsville, Alabama
NASA	National Aeronautics and Space Administration, Washington, D.C.
NRA	NASA Research Announcement
OLMSA	Office of Life and Microgravity Sciences and Applications
PDR	Preliminary Design Review
PI	Principal Investigator
PM	Program Manager
POP	Program Operating Plan
PS	Project Scientist
PSR	Preship Review
RDR	Requirements Definition Review
SCR	Science Concept Review
SOW	Statement of Work

Contract: Mutually binding legal relationship obligating the seller to furnish supplies or services, and the buyer to pay for them.

Cooperative Agreement: Legal instrument with the same basis as a grant, but anticipating substantial involvement between NASA and the recipient during the performance of the activity.

Grant: Legal instrument where the principal purpose is the transfer of anything of value to the recipient to accomplish a public purpose of support or stimulation as authorized by a Federal statute.

Appendix 2
Authority To Proceed (ATP)

The Microgravity Research Program Office's granting of Authority to Proceed (ATP) with a project is detailed in a NASA/Marshall Organizational Work Instruction (MRPO-OWI-MG01.6, May 5, 1998). For convenience, it is outlined here. However, this should be treated as a summary only. All NASA decisions will be guided by the most current version of the OWI.

Following an SCR

Science Concept Review (SCR)

The SCR Panel report is forwarded to the OLMSA Enterprise Discipline Scientist at NASA Headquarters who recommends, with the concurrence of the MRD Lead Scientist, the disposition.

The MRD Director will

- Decide to terminate, or
- Decide to continue and informs MRPO in writing.

The MRPO will

- Determine whether resources are available,
- Present information to MSFC Management
- Issue an ATP on the project, and
- Inform the PI in writing, including specific SCR Panel recommendations that the MRD Director may want to emphasize.

Following other reviews

Requirements Definition Review (RDR), Conceptual Design Review, Investigation Continuation Review (ICR), or other review

The science panel report is forwarded to the OLMSA Enterprise Discipline Scientist at NASA Headquarters who recommends, with the concurrence of the MRD Lead Scientist, the disposition.

The MRD Director will

- Decide to terminate, or
- Decide to continue and informs MRPO in writing

The MRPO will

- Be directly accountable for cost, schedule and performance,
- Inform the MRD if it finds that resources are insufficient, or that a project is unacceptable for reasons of cost estimate, schedule projection, or technical performance or execution,
- Present appropriate information to ensure funding availability if funding comes from a source outside MRP (*e.g.*, Space Station Program Office),
- Present information required by MSFC Management,
- Issue the ATP, and
- Inform the PI of the satisfactory completion of the review.

Appendix 3
Science Concept Review (SCR)

Formal outline

The Science Concept Review (SCR) addresses nine major areas relevant to an experiment. For the best chance of success in the SCR, the Principal Investigator should study these points and the details that lie behind them, and be prepared to anticipate questions that the SCR panel —typically comprising four to six persons — may ask (be especially prepared for questions you might wish to avoid; those tend to get asked). Other aspects of the presentation are listed in the next section. The nine "charges to the panel," and the details behind them, include:

1. Significance

1. The significance of the problem being investigated including the benefits that the experimental and theoretical results would provide to the research community and industry.

- "The problem" is that proposed in the original NRA proposal. This could be the hypothesis to be tested, or the observation to be made.
- The PI must assume that the panel never read the original proposal and does not share the comments or support of the original reviewers. Each Science Panel Review is from a "clean sheet" (Office of Life and Microgravity Science and Applications policy).
- Why is the solution of "the problem" important to the science community biotechnology? What is its priority compared to other problems in the discipline?
- Is the solution of "the problem" important to industry? If so, why?

2. Maturity

2. The maturity of the overall scientific investigation.

- Does the PI work in this field? Publish in the field? How long? Who are coworkers, and how established are they in the field?
- Does the PI (and his/her team) have personal experience in the theoretical and experimental work required to address "the problem"?
- Has the PI completed or been funded for earlier "ground-based" work on this specific research topic? Has that work been published?
- Is the PI's team assembled?
- Are the PI's facilities established and ready?

3. Objectives

3. The scientific objectives of the proposed flight experiments.

- Clearly state the scientific objective(s) of the flight experiment(s).
- How does accomplishment of the science objectives lead to a solution of "the problem"?
- What is to be measured during the flight experiments (or measured after flight based on a specimen produced during flight)?
- What boundary conditions are needed (thermodynamic, microgravity, etc.)?
- What experiment matrix must be completed to complete the science objectives?

4. The need for a microgravity environment to achieve the proposed scientific objectives.

4. Need for microgravity

- Why is microgravity needed?
  - Why not have the Federal Government spend money or time on ground-based research to get the same results? *Note: the answer is not "because the proposal was to do microgravity experiments."*
  - What are earth-based alternatives to gather the data, and what are their drawbacks?
  - How does the PI know these alternatives are not sufficient?
  - Why can't experiment boundary conditions be changed to make acceleration body fields (gravity) less important?
  - Why not use electromagnetic body fields (Lorentz effect) to get the same effect, or change the specimen (material) under study so that such a field could be used?
- What type/quality of microgravity is needed?
  - Describe the acceleration magnitude, orientation with respect to the specimen and/or boundary conditions, and frequency dependence (for dynamic accelerations).
  - What is the PI's assessment of whether the Space Shuttle or International Space Station can provide the required acceleration levels?
  - What is NASA's assessment?
- Finally, what is the justification for the answers to the questions above?
  - Observations in the refereed literature or community discussions (including prior microgravity experiments)?
  - Numerical or analytical models of the PI?
  - Ground experiments in various orientations with respect to gravity, or under magnetic fields, or density matching model experiments by the PI?
  - Drop tube or parabolic aircraft experiments by the PI?

5. The priorities of these scientific objectives.

5. Priorities

6. The rigor with which the proposed flight experiment has been conducted terrestrially. (e.g., influence of gravity, reproducibility and quantification of experimental conditions and results, materials characterization, modeling, application/verification of current and/or developing theoretical framework, etc.)

6. Rigor of ground-based tests

- Has the PI produced boundary conditions and made measurements with the accuracy, precision and resolution required to satisfy the science objectives in his/her laboratory, using laboratory equipment?
- Has the PI used techniques or technologies applicable to flight experiments (*e.g.,* small, low power consumption)?
- Has the PI published the results?
- Has the PI made these measurements on the same specimen material(s) proposed for study in microgravity?

7. Scientific specifications

7. The scientific specifications for the proposed flight experiments as expressed in the preliminary draft of the Science Requirements Document.

- This information must be presented three times, to the Non-Advocate Review, the SCR's advance presentation package (provided two weeks in advance), and the draft Science Requirements Document (SRD). The information should progress from a higher level to a lower level, from less detail to more detail:
    - The "Problem"
    - The Science Objective(s)
    - The Flight Experiments (Test Matrix)
    - The Specifications of the Flight Experiment(s)
    - The Apparatus/Operations needed to conduct the Flight Experiments

Description of the scientific specifications must include the following topics:

- What Boundary Conditions are to be generated for the specimen under study?
    - Temperature (and time and spatial variations of)
    - Pressure (same)
    - Other thermodynamic conditions (same)
    - Specimen size, composition (and time and spatial variations of)
    - Acceleration levels
    - How accurate must each of these be? What are the error bars allowable that still allow the science objectives to be met? What does this imply for the control of these boundary conditions (resolution, accuracy and precision of measurement used for control)?

- What measurements are to be made of the specimen under study?
    - Temperature (and time and spatial variations of)
    - Pressure (as above)
    - Other thermodynamic conditions (as above) - phase interface shape/size, rates of phase transformation, etc.
    - Thermophysical properties
    - Specimen size, composition (and time and spatial variations of)
    - Acceleration levels
    - What resolution, precision and accuracy must each of these measurements be made to? What are the error bars allowable that still allow the science objectives to be met?

- What general types of scientific apparatus would be expected to produce satisfactory boundary conditions and make satisfactory measurements?

- What must engineering specifications be for equipment to generate these boundary conditions and make these specimen measurements?

8. The conceptual design for the apparatus and whether this design could be expected to deliver a level of performance that allows the scientific objectives to be achieved.

Unless the PI is developing the flight apparatus, the NASA members of the team will present this information. However, the apparatus concept must be based on the information generated from the prior question, and definition of the apparatus concept is a joint activity with the PI.

- The description provided should be at the Block Diagram/Isometric Sketch level
- Major elements should be described (e.g., we need a temperature-controlled chamber of this size and configuration, a Data Acquisition System, motors, etc.)
- Rough assessment: can this be done within constraints of NASA's available spacecraft?
- Does need for "repackaging or 'space hardening" of laboratory apparatus lead to a need for new technology?

9. Technology issues

9. Technology issues that would prevent a timely, successful achievement of the scientific objectives.

- Is any new technology needed (boundary conditions, specimen preparation, measurements/diagnostics)?
- Advances in the accuracy, resolution or precision of measurement?
- Who will develop the technology as part of Phase B? How much will it cost?

Practical aspects

The SCR is more than just a set of briefing charts that follow the outline of the "nine charges to the panel." You should start preparing for the SCR about two months after you receive the ATP, and be ready for a dry run two months before the scheduled SCR. Lessons that you should follow from others' SCRs includes:

Preparation and content

SCR package preparation and content

- NASA will provide examples of successful presentations.
- Include in the data package an introduction, the presentation charts, draft SRD, and the NRA proposal.
- Discuss all of the "nine charges" in presentation charts and SRD. None is considered "N/A." At the end, summarize how the nine charges were covered.
- As much as practicable, have each page of presentation give cross-reference to SRD page and paragraph numbers plus appropriate SCR charge number.
- Number the pages on all charts and in all documents. This will be critical when referring to pages during review.
- Use color on charts to distinguish data, graphical uniqueness, and hardware cross-sections—but not for its own sake.
- Make graphs legible and self-explanatory.
- Give a strong case showing need for microgravity.
- Show ground experiment data — they are essential.

- Show strong modeling capabilities coupled with strong experimental capabilities, where applicable — they are impressive.
- Give an unambiguous description of data to be obtained from experiment. This requires that you have a good description of technical application of data: how it can be useful to industry and American taxpayers, the priorities of processing with respect to experiment's goals and applicability to potential importance in biotechnology discipline (*i.e.,* how does it fit in for future advancement in biotechnology either for research, technology, industrial application, commercial use).
- Take SRD seriously. The panelists read the SRD.
- Include a one-page synopsis of requirements in the SRD.
- Have all members of your project team read your SRD and provide inputs, corrections, and questions to PI. Ensure consistency with presentation where applicable.
- Provide the package in 3-ring notebook to allow easy addition of other materials.

Preparation

Review preparation

- Dry-runs are a necessity. Practice helps to get thoughts and charts organized and guards against conflicts in presentation. This is the forum for honest and constructive critique of the material and format. It is essential to have non-advocate makeup of MSFC personnel, who have SCR experience, attend the dry-run. If these were organized into an SCR-type review panel, it would offer a more realistic exercise for the PI and other presenters.
- Having panel members who are objective to science being reviewed is important. Initiate review panel membership selection by obtaining suggested names of peers from PI. This is worked between PI and the Project Scientist (PS) and then submitted to the Discipline Scientist (DS), who works with the Enterprise Scientist (ES) to establish chairman and the remainder of panel. A total of four including the chairman is the suggested number of panel members.

Proceedings

Review proceedings

- Introduce other participants — briefly — if time allows.
- At beginning of the, review, the Enterprise or Discipline Scientist will give the panel a detailed, "bell ringing" 15-30 minute charge. Panelists remind each other over the course of the review of elements from this charge.
- Do not use the "nine charges" directly as your presentation outline. Give the presentation in a naturally flowing order *with the nine charges imbedded* in the discussion. Conclude with a summary of the nine charges.
- Keep presentation flowing. Have presenters available and ready.
- Use as few acronyms as possible.
- Occasional humor is good — but avoid flippancy.
- NASA/Marshall will discuss manifest opportunities and options available for whatever platform is applicable, in case such questions arise.

- On any analysis or modeling presented, define assumptions and discuss options considered to be the rationale for decision. Be prepared to discuss methodology and/or boundary conditions.
- You might be asked questions like ''why can't you get the results without going to space?" — so be ready with solid answers.
- Have ground, prototype or flight hardware to pass around, if possible. It need not be the entire unit, but could be the element that holds or manipulates the samples.
- When dealing with experiment ground or flight development, be ready to discuss rationales for prioritization of processing samples or processing criteria. If experiments have multiple samples to be processed, be prepared to discuss processing order, process time, and what unique, unambiguous data are to be obtained. Always have an answer about priority of experiment development, processing and data acquisition.
- With regard to presentation of raw data, be prepared for questions regarding the statistical treatment of these data and how ''fitting'' techniques are employed. Be prepared to answer how data points are dropped and why.

Logistics and hospitality

Logistics and hospitality

- Access to a facility where ground hardware or breadboards (if existing) can be visited or viewed is a plus.
- Get good estimate of number who will be attending review and have appropriate quantity presentation copies available. Panelists should always have the "bells and whistles" version (color graphs, pictures, etc.)
- Have at least two viewgraph projectors — and spare bulbs. If you plan to use a computer projector, then have a set of viewgraphs and an overhead projector available as a backup.
- Make menus available before the presentation begins so all attendees may order lunch, then have lunch delivered to the review room. This is more efficient and courteous.
- Seat panel members at front table facing screen and everyone else behind them. Have comfortable chairs for panelists.
- Provide a public address system.
- Tape discussions for later documentation.

Appendix 4
Requirements Definition Review (RDR)

The Requirements Definition Review (RDR) starts the Phase B Hardware Definition Phase. The purpose of the Hardware Definition Phase is to establish a hardware concept capable of performing the defined experiment and to develop a project baseline with plans, budget, and schedules sufficient to allow commitment to hardware development, hence the need for a rigorous, in-depth review.

The phase begins with the authority to proceed to RDR, pending approval of the RDR Plan. At this point the Project Manager and Project Scientist develop the RDR Plan and negotiate it with the Program Manager and Program Scientist who have approval authority. This plan will include the organization, approach, schedules, and resources, plus the hardware implementation approach(es) which will be considered. Upon approval of the RDR Plan the Project Manager, Project Scientist and Principal Investigator proceed to finalize the science requirements, develop the experimental concept, establish engineering feasibility, and develop the necessary project baseline including plans schedules, and cost.

The objectives and information to be presented in the RDR are shown at left. For the most part, they resemble those of the Science Concept Review, with the addition of maturing hardware designs and cost plans. The RDR is conducted by two subpanels — Engineering/Program and Science — who make recommendations regarding the maturity of the science requirements, the engineering feasibility, and the project planning. The Engineering/Program subpanel also conducts an in-depth non-advocate cost review of the proposed experiment. Its recommendations resulting from this non-advocate review become a part of their report to the Program Manager and Enterprise Discipline Scientist who will recommend — with the concurrence of the Microgravity Research Division (MRD) Lead Scientist — to the MRD Director whether that the activity should proceed to the flight development phase or that further work be done. After assessing the results of the RDR, the MRD Director decides on the commitment to flight development. Once a commitment

Objectives

- Reaffirm the science requirements
  - Review the final science requirements
  - Reassess the need for microgravity
- Assess the engineering feasibility
  - Review the conceptual design
  - Affirm that there are no outstanding engineering or technology issues
  - Assess the compatibility of the science requirements and the hardware design
  - Confirm the carrier recommendation
  - Assess the requirements with safety and mission requirements
- Assess the project planning
  - Review the approach to schedules and resources
  - Assess the cost development

Information presented

- Science requirements
- Conceptual design
  - Engineering feasibility results
  - Payload classification
  - Vibroacoustic issues
  - Data archival requirements
- Hardware capabilities and comparison
- Carrier selection and mission implications
- Project plans, organization & schedule
- Plans for high risk subsystems
- Action status from science concept review
- Cost with justification and cost containment strategy

is made, the project produces the signature copies of the Project Plan and the Science Requirements Document, and modifies or produces — as appropriate — the Hardware Capabilities Document.

The RDR represents the baseline process. However, alternative approaches will be considered. If the managing NASA Center wishes to take an alternate approach and forego the RDR, then it should address how the objectives of the RDR will be met and how the information normally found in the RDR will be made available in order to establish that the project is ready to proceed to flight development. This information will be needed to support the RDR Plan that will be generated at the beginning of this phase.

There is also an additional requirement during the Hardware Definition Phase regarding the involvement of the carrier integration personnel in the development of the project plans and schedules. The Project Manager is required to establish an interface with the carrier integrator at the appropriate time before the RDR in order for the project plans, schedules and resources to properly reflect flight vehicle integration and safety issues. During the RDR the carrier integrator should affirm (where feasible) that the carrier can meet the needs of the experiment and the Project Manager should affirm that the integration requirements are properly reflected in the project plans schedules and resources.

At the beginning of the Hardware Definition Phase, the options regarding the most appropriate hardware should encompass the possible use of international as well as domestic flight hardware. If international hardware is chosen, the experiment will be carried through the RDR process to ensure that the science requirements and hardware capabilities are fully understood and to allow for negotiations if necessary. The Program Scientist is responsible for establishing the necessary interfaces and arranging for the reviews.

Appendix 5
Investigation Continuation Review (ICR)

When a flight experiment has performed exceptionally well, or when one was halted for unforeseen reasons, a reflight may be proposed. This is determined by an Investigation Continuation Review (ICR) previously called the Hardware Reflight Review (MHRR). This is held after the engineering and scientific data from the previous flight have been sufficiently analyzed to ensure an understanding of the operation of the experiment, the science return, and the problem (if one occurred). This review may be waived upon a recommendation from the Chief of the Science Branch and approval of the MSAD Division Director. Passing the ICR should not be taken as a "given." *The Principal Investigator must be prepared to rejustify his experiment with the same rigor and detail as from the beginning of the project.*

The PI must also be aware that he or she is, in effect, making two presentations, one to the science panel and one to the engineering panel. There will be some overlap in materials used, but the two panels will have distinctly different concerns.

The ICR **Science Panel** will review the reflight request based on these criteria:

- Scientific merit,
  - Are the scientific and technical objectives within the boundary of the *original* approved proposal?
  - What is the significant scientific advance expected to be made by a reflight?
  - What ground-based advances have been made toward meeting the *original* science objectives?
- Microgravity relevance,
  - What compelling need exists for performing research in the microgravity orbital environment?
  - What options exist to achieve the proposed scientific objectives in ground-based facilities?
- Data analysis,
  - How are the flight data to be analyzed and compared with ground-based data?
  - What experimental error is expected from the space data and the comparison with ground-based data?
- Test matrix and experimental approach,
  - What are the requirements for the sample, number of runs, temperature, temperature measurement, mission environment, and other specific resources?
  - What are the experimental method and approach?

Typical ICR schedule

Welcome
Charge to Science & Engineering Review Panels
Science Presentation
Hardware Presentation
Documentation Status
Schedules
Project Plan
Budget
Science and Engineering Panels Caucus
Feedback to P.I. by Review Panels
Concluding Remarks
Adjourn

Note: Depending on the complexity of a project, the ICR can take the afternoon of one day and the morning of the next, or two full days. Not shown here are breaks, meals, etc.

The ICR **Engineering Panel** will review the reflight request based on these criteria:

- Hardware capabilities,
  - What modifications must be made to ensure successful completion of the science objectives?
  - Are the necessary modifications being fully or partially incorporated into the hardware?
- The differences between the new experiment to be flown and the previously flown experiment,
- The required rework and/or modification of the hardware or software.
- Status of project planning,
- Hardware specifications are derived from the SRD and addendum,
- The design of proposed changes (if any) to the experiment apparatus,
- Documentation status,
- Schedule for development,
- Manifest opportunities,
- Technology issues that could prevent successful achievement of the objectives, and
- The reflight budget.

As with the SCR and RDR, hold a dry run 60 to 90 days before the ICR.

The MSAD Program Manager will approve the extent of the hardware reflight review process based on recommendations from the managing center and his or her assessment of the program on a case-by-case basis. *In any event, the review(s) will satisfy the requirements for all four of the standard reviews* (i.e., *SCR, RDR, PDR & CDR).*

Following the oral presentations, the peer review panels may meet in private to provide the Headquarters Enterprise Scientist with their frank appraisal of the investigation and the benefits of a reflight. A formal written review is provided by each panel to the Enterprise Scientist and the Discipline Program Manager within two weeks.

Appendix 6
NASA Forms 533M and 533Q

(note: may be copied as needed)

Forms and instructions and instructions for the Monthly (533M) and Quarterly (533Q) reports are on the next four pages. In completing these reports, you should use calendar months and Federal fiscal quarters rather than time since award of your contract. For example, if ATP is received in the middle of the month, count that period as a full month. The same should be done with quarters. This will make your reports conform with standard Federal accounting methods.

Federal fiscal year quarters:
1 — Oct. 1-Dec. 31.
2— Jan. 1-March 31.
3 — April 1-June 30.
4 — July 1-Sept. 30.

PAGE_____ OF_____ PAGES

NASA
National Aeronautics & Space Administration

Monthly Contractor Financial Management Report

Form Approved
OMB NI. 2700-0003

TO:	FROM:	2. REPORT FOR MONTH ENDING AND NUMBER OF OPERATING DAYS	
		3. CONTRACT VALUE a. COST $	b. FEE $
1. DESCRIPTION OF CONTRACT — a. TYPE	b. CONTRACT NO. & LATEST DEFINITIZED AMENDMENT NO.	4. FUND LIMITATION $	
c. SCOPE OF WORK	d. AUTH. CONTR. REP. (Signature) — DATE	5. BILLING a. INVOICE AMTS.. BILLED $	b. TOTAL PYTS. REC'D $

6. REPORTING CATEGORY	7. COST INCURRED/HOURS WORKED				8. ESTIMATED COST/HOURS TO COMPLETE			9. ESTIMATED FINAL COST/HOURS		10. UN-FILLED ORDERS OUTSTANDING
	DURING MONTH		CUM TO DATE		DETAIL		BALANCE OF CONTRACT c.	CONTRACTOR ESTIMATE a.	CONTRACT VALUE b.	
	ACTUAL a.	PLANNED b.	ACTUAL a.	PLANNED b.	a.	b.				

Baseline Plan Identification (Col 7b& 7d): Revision No.. ______________________ Dated ____________

General — All paragraph references below refer to the current edition of NHB 9501.2, which includes additional instructions for completing NASA Form 533 reports. Copies of the Handbook are available through the NASA Contracting Officer or from the Superintendent of Documents, Government Printing Office, Washington, DC 20401.

Forms — Forms will be obtained by the contractor through the contracting officer. When directed or approved by the contracting, other means than the NASA 533 format may be used for transmitting the data required by these instructions; e.g., punched cards, tapes or electronic transmissions.

Security Classification — If the information in the report is classified, appropriate security classification shall be given the report (see par. 107).

Submission — The NASA Form 533 report is due in the office of the addressee not later than 10 operating days following the close of the contractor's monthly accounting period, unless otherwise specified in the contract. For initial reports and other related items of significance, see par. 300, 301 and the contract. The addresses and number of copies to be submitted will be as specified by the contract or an administrative instruction.

Amounts — Report dollar amounts in even thousands and hours in tenths of thousands (e.g., $32,600 as $33 or 462 hours as .5).

Form Headings — The form headings shall be completed as follows:

1. To — Enter the full name and address of the NASA field installation and contracting officer or other designated recipient.
2. From — Enter the full name and address of the contractor and, if applicable, the contractor's division performing the contract.

Preparation:

1. Description of Contract:
    a. Type — Cost-Plus-Fixed-Fee, Cost-Plus-Incentive-Fee, etc.
    b. Contract No. and Latest Definitized Amendment No. — Enter complete letter or contract symbol, number, and number of latest definitized amendment.
    c. Scope of Work — Enter a brief description of the contract effort. Identify the service, project, system or subsystem and, where hardware is concerned, the quantity being procured or proposed for the contract.
    d. Authorized Contractor Representative (Signature) and Date — The authorized contractor representative shall sign and date to reflect approval. When such representative is other than the project manager, the project manager shall also sign to signify review of the content. Date shall signify date of approval and signature of report.
2. Report for Month Ending and Number of Operating Days — Enter the ending date of the contractor's accounting month and the number of operating days for that accounting month.
3. Contract Value — Enter the total definitized cost (a) and fee (b) of all work to be performed under the contract as of the report date. Include dollar amounts through the latest definitized amendment as noted in 1b above. For all incentive contracts, enter the negotiated target cost and target fee.
4. Fund Limitation — Enter the total funding obligated and the latest corresponding contract amendment number as of the report date.
5. Billing:
    a. Invoice Amounts Billed — Enter the total amount of invoices billed by the contractor against the contract and the latest invoice number as of the report date.
    b. Total Payments Received — Enter the total amount of payments received by the contractor for the contract as of the report date.
6. Reporting Category — Enter the captions of the reporting categories specified in the contract (see par. 301-3).
7. Cost Incurred/Hours Worked — All cost and hour data will be reported by the categories negotiated in the contract (see par. 301-4).
    a. Actual During Month — Enter the total actual cost incurred/hours worked for the accounting month being reported.
    b. & d. Planned Cost (optional) — Enter the planned (budgeted) cost for the month being reported in column 7b and cumulative to date in column 7d. The planned cost is obtained from the time phased baseline plan which includes the original contract value plus authorized changes. The baseline plan to date consists of the sum of the budgets for all work authorized that is scheduled for completion through the report date. The plan shall include a pro rata share of the budgets for work in process. Identify the baseline plan used by date and revision number at the bottom of the report.
    c. Cumulative Actual Cost/Hours to Date — Enter the cumulative actual cost incurred/hours worked as of the report date. Where the cumulative data reported in this column is only for the current "schedule," the report should be annotated to show the total cumulative cost for all previous "schedules."
8. Estimated Cost/Hours to Complete — Enter the current estimates for performing currently authorized work which is included in the most recently executed contract amendment, plus additional authorized work (directions to proceed) for which execution of amendments is pending. The estimates will be used for planning purposes only and will not be binding on either the contractor or NASA.
    a. & b. These columns may be used at the option of project management to obtain any desired combination of subsequent month(s), fiscal year(s), and/or balance of fiscal year data. The required data element(s) shall be specified in the contract (see par. 301-5).
    c. Enter the cost/hour data for the balance of the contract not including columns 8a and 8b. Where amounts reported in this column exceed one fiscal year, a breakdown by fiscal year may be required.
9. Estimated Final Cost/Hours:
    a. Contractor Estimate — Enter the total estimated cost/hours for completion of the contracted effort (this should equal the sum of columns 7c, 8a, 8b and 8c).
    b. Contract Value — Enter the distribution of the Contract Value to the reporting categories. The total of this column shall agree with item 3, above. Significant differences between columns 9a and 9b shall be explained in the "Contractor's Remarks." When there are no changes from the prior reports submitted, the data may be omitted if the contractor and the NASA contracting officer jointly agree.
10. Unfilled Orders Outstanding — Enter the total of unfilled orders outstanding as of the report date (see par. 301-6).
11. Contractor's Remarks:
    a. Analytical remarks on significant items materially affecting historical or projected cost or performance shall accompany each monthly report (e.g., see item 9b above and par. 304).
    b. Include a reconciliation from the original contract value (Original Negotiated Baseline) to the present contract value as reported in item 3. A sample format is set forth in the instructions on the back of NASA Form 533Q and par. 304.
    c. The NASA field installation may require changes authorized but not finalized to be further subdivided as follows:
        (1) Changes negotiated but not definitized
        (2) Changes pending negotiation
        (3) Changes pending quotation
    d. Report new change orders per sample format set forth in the figure below.

NASA
National Aeronautics & Space Administration

Quarterly Contractor Financial Management Report

Form Approved
OMB NI. 2700-0003

2. REPORT FOR MONTH ENDING AND NUMBER OF OPERATING DAYS

FROM:

3. CONTRACT VALUE

a. COST
$

b. FEE
$

1. DESCRIPTION OF CONTRACT

a. TYPE

b. CONTRACT NO. & LATEST DEFINITIZED AMENDMENT NO.

4. FUND LIMITATION
$

c. SCOPE OF WORK

d. AUTH. CONTR. REP. (Signature)

DATE

5. BILLING

a. INVOICE AMTS.. BILLED
$

b. TOTAL PYTS. REC'D
$

6. REPORTING CATEGORY	7. COST INCURRED/ HOURS WORKED			8. ESTIMATED COST/HOURS TO COMPLETE										*9. EST. FINAL COST/HOURS*		*10. ESTIMATED COMPLETION DATE*	*11. UNFILLED ORDERS OUTSTANDING*
	CUMULATIVE ACTUAL THROUGH PRIOR MONTH a.	*CURENT MONTH ESTIMATE b.*	*CUMULATIVE ESTIMATE TO DATE c.*	*MONTH a.*	*MONTH b.*	*MONTH c.*	*QUARTER d.*	*QUARTER e.*	*QUARTER f.*	*BALANCE OF FY- d.*	*NEXT FY- e.*	*BALANCE OF CONTRACT g.*	*TOTAL TO COMPLETE h.*	*CONTRACTOR ESTIMATE a.*	*CONTRACT VALUE b.*		

General — All paragraph references below refer to the current edition of NHB 9501.2, which includes additional instructions for completing NASA Form 533 reports. Copies of the Handbook are available through the NASA Contracting Officer or from the Superintendent of Documents, Government Printing Office, Washington, DC 20401.

Forms — Forms will be obtained by the contractor through the contracting officer. When directed or approved by the contracting, other means than the NASA 533 format may be used for transmitting the data required by these instructions; e.g., punched cards, tapes or electronic transmissions.

Security Classification — If the information in the report is classified, appropriate security classification shall be given the report (see par. 107).

Submission — The NASA Form 533Q report is due in the office of the addressee on a quarterly frequency (i.e., calendar quarter or other designated 3-month interval) not later than the 15th day of the month preceding the quarter being projected in columns 8a, b and c. For initial reports and other related items of significance, see par. 300-5, 302 and the contract. The addresses and number of copies to be submitted will be as specified by the contract or an administrative instruction.

Amounts — Report dollar amounts in even thousands and hours in tenths of thousands (e.g., $32,600 as $33 or 462 hours as .5).

Form Headings — The form headings shall be completed as follows:

1. To — Enter the full name and address of the NASA field installation and contracting officer or other designated recipient.
2. From — Enter the full name and address of the contractor and, if applicable, the contractor's division performing the contract.

Preparation:

1. Description of Contract:
    a. Type — Cost-Plus-Fixed-Fee, Cost-Plus-Incentive-Fee, etc.
    b. Contract No. and Latest Definitized Amendment No. — Enter complete letter or contract symbol, number, and number of latest definitized amendment.
    c. Scope of Work — Enter a brief description of the contract effort. Identify the service, project, system or subsystem and, where hardware is concerned, the quantity being procured or proposed for the contract.
    d. Authorized Contractor Representative (Signature) and Date — The authorized contractor representative shall sign and date to reflect approval. When such representative is other than the project manager, the project manager shall also sign to signify review of the content. Date shall signify date of approval and signature of report.
2. Report for Quarter Beginning — Enter the beginning date of the quarter being projected in columns 8a, b and c and the number of operating days in the quarter..
3. Contract Value — Enter the total definitized cost (a) and fee (b) of all work to be performed under the contract as of the report date. Include dollar amounts through the latest definitized amendment as noted in 1b above. For all incentive contracts, enter the negotiated target cost and target fee.
4. Fund Limitation — Enter the total funding obligated and the latest corresponding contract amendment number as of the report date.
5. Billing:
    a. Invoice Amounts Billed — Enter the total amount of invoices billed by the contractor against the contract and the latest invoice number as of the report date.
    b. Total Payments Received — Enter the total amount of payments received by the contractor for the contract as of the report date.
6. Reporting Category — Enter the captions of the reporting categories specified in the contract (see par. 302-3).
7. Cost Incurred/Hours Worked:
    a. Enter the cumulative actual cost incurred/hours worked through the first two months of the quarter preceding the quarter projected in columns 8a, b and c. Where the cumulative data reported in the column is only for the current "schedule," the report should be annotated to show the total cumulative cost for all previous "schedules."
    b. Enter an estimate for the month in which the report is due (see "Submission" above).
    c. Enter the sum of columns 7a and b.
8. Estimated Cost/Hours to Complete (columns 8a through i) — Enter the appropriate month, quarter and fiscal year designations in the column headings. Enter the current estimates for performing currently authorized work which is included in the most recently executed contract amendment plus additional authorized work (directions to proceed) for which execution of amendments is pending. These estimates will be used for planning purposes only and will not be binding on either the contractor or NASA. The sum of columns 8a through i will be entered in column 8j. If the totals reported in column 8i, "Balance of Contract," exceed more than one fiscal year, each fiscal year shall be identified and reported separately.
9. Estimated Final Cost/Hours:
    a. Contractor Estimate — Enter the total estimated cost/hours for completion of the contracted effort for each reporting category. This should equal the sum of columns 7c and 8j.
    b. Contract Value — Enter the distribution of the Contract Value to the reporting categories. The total of this column shall agree with item 3, above. Significant differences between columns 9a and 9b shall be explained in the "Contractor's Remarks." When there are no changes from the prior reports submitted, the data may be omitted if the contractor and the NASA contracting officer jointly agree.
10. Estimated Completion Date — Enter the estimated completion date for each sub-division of the work if a correlated cost schedule activity is not required. The entry shall not serve as a notice to NASA of late delivery or as acquiescence in such late delivery by NASA.
11. Unfilled Orders Outstanding — Enter the total of unfilled orders outstanding as of the report date (see par. 302-6).
12. Contractor's Remarks — The narrative report submitted with the quarterly cost projection report shall normally be limited to those items materially affecting projected cost or performance which have not been addressed in the preceding monthly narrative reports (see par. 304).
    a. Explain any significant items affective cost; e.g., technical and schedule problems, changes in plans, incurred over/under runs, etc.
    b. Include a reconciliation from the original contract value (Original Negotiated Baseline) to the present contract value as reported in item 3. A sample format is set forth in Figure A below.
    c. The NASA field installation may require changes authorized but not finalized to be further subdivided as follows:
        (1) Changes negotiated but not definitized
        (2) Changes pending negotiation
        (3) Changes pending quotation

d. Report new change orders per sample format set forth in Figure B below.

Appendix 7
Data update form
(note: may be copied as needed)

FY98 Data Update Form
Microgravity Research Division

PI's Last Name	**First Name**	**Middle Initial**	**Prefix**	**Suffix**

Affiliation

Phone:	**Fax:**	**E-mail:**

Address :

Task Research Title

Monitoring Center	MSFC	NAG number
Research type	Ground — Flight	Discipline
Initiation date		Expiration date

Degree	Students	Degrees granted
B.S.		
M.S.		
Ph.D.		
Totals		

Continues on next page

Co-Investigator name	Co-Investigator affiliation

Impact on America

This section has been added so that we can better understand the impact that NASA funded microgravity research has on America. To do this, we have included several new fields that we believe best capture this impact. All of the information provided should be for the current fiscal year only.

Industrial Affiliates

Please list any industry research contacts you may have

Who is using the results of your research?

Have you developed any innovative technologies, and if so, what are they?

Where have your recent graduate students found employment?

Continues on next page

Acronyms (Please list and define any acronyms associated with your project)

Number of times that your work has appeared in the popular press?

Number of times that your work has appeared on a magazine cover?

PI's are asked to submit the following information for each investigation

Task Objective

Task Description

Task Significance

Task Progress (*Needs to be updated each year*)

Bibliography
Please list citations for FY 1998 only (see next page for sample listing)

Form concludes; sample citations on next page

FY98 Bibliographic Citations By NASA MSAD Task Pi's
(Oct 1, 1997 - Sept. 30, 1998 **0nly**)

Please do not include in press or submitted publications—include only those publications that actually appeared in FY98. If you are creating this list from scratch, please try to follow the examples below, including noting what each type of bibliographic citation is. If you have more than a single task being funded by NASA Marshall Space Flight Center, make sure that you don't lump all your bibliographic citations into one long list (divide the citations into separate lists and keep them with the associated task). If you include a citation that doesn't cite the pi as an author, make sure that the Co-I is also listed on the task information sheet.

<u>Book</u>
Andrews, J.B. "Solidification of Immiscible Alloys" in "Immiscible Liquid Metals and Organics." L. Ratke, ea., DGM Informationsgesellschaft. Verlag Press, 199-222, 1993.

<u>Journal</u>
Feng, H.J., and Moore, J.J. Combustion synthesis of high performance ceramic-metal composites. *High Performance Metal and Ceramic Matrix Composites*, TMS, K. Upadhya, ed., 157-174 (1994).

<u>Journal</u>
Fischer, B., and Finn, R. Non-existence theorems and measurement of capillary contact angle. *Zcit AnaL Anwend*., 12, 405-423 (1993).

<u>NASA Tech Brief</u>
Lee, H.S., and Merte, H. Jr. Vapor bubble dynamics in microgravity, report NASA Contract NAS-3-25812. Report No.UM-MEAM-93-10. University of Michigan, Department of Mechanical Engineering and Applied Mechanics. NASA Tech Brief (December 1993).

<u>Proceedings</u>
Cheney, A.B., and Andrews, J.B. "The evaluation of ampule materials for low-g processing of immiscible alloys." Proceedings of the 6th International Conference on Experimental Methods for Microgravity Materials Science, TMS, R.S. Schiffman and J.B. Andrews, eds., 191-197 (1994).

<u>Proceedings</u>
Zhou, W., Wu, J., Dudley, M., Su., C.-H., Volz, M.P., Gillies, D.C., Szofran, F.R., and Lehoczky, S.L. "Characterization of growth defects in ZnTe single crystals." Materials Research Society Proceedings, Infrared Detectors —Materials, Processing, and Devices, A. Applebaum and L.R. Dawson, eds., 299 (1993).

<u>Presentation</u>
Atreya, A., Agrawal, S., Sacksteder, K.R., and Baum, H. "Observations of methane and ethylene diffusion flames stabilized around a blowing porous sphere under microgravity conditions." AIAA-94-0572, presented at the 32nd AIAA Aerospace Sciences Meeting, Reno, Nevada, January 1994.

<u>Presentation</u>
Concus, P. "Equilibrium capillary surfaces: theory and space experiments." American Physical Society. Fluid Dynamics Division Annual Meeting, Albuquerque, New Mexico, November 1993.

Sample only

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National Aeronautics and
Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812